IRRIGATION WITH EFFLUENT:
Will Salinity Become a Problem?

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WHERE DO SALTS COME FROM??

- Irrigation: Low to High
- Precipitation: Low
- Soil: Low to High
- Water Table: Salts Rise Into Drier Soil
SALINITY MANAGEMENT

Irrigation: Add Salts

Proper Salt Balance

Drainage: Lose Salts
TURF WATER BALANCE
Linked to Salt Balance

Inputs: Irrigation & Precipitation
Losses: Evapotranspiration, Runoff & Drainage
WILL SALINITY BECOME A PROBLEM?

It Already Has!!

- Water Supply
  - Quantity
  - Quality
- Irrigation System
  - Non-Uniformity
  - Precipitation Rate
- Playability
- Drought
USABLE WATER SUPPLY IS ALWAYS LESS THAN POTENTIAL
# Evaluation of ADWR Water Duties for Large Turf Facilities

<table>
<thead>
<tr>
<th>% of Duty Infiltrating Soil</th>
<th>% of Precipitation Lost to Runoff (Normal Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>In</td>
</tr>
<tr>
<td>100</td>
<td>8.6</td>
</tr>
<tr>
<td>95</td>
<td>5.7</td>
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<td>90</td>
<td>2.8</td>
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<tr>
<td>85</td>
<td>-0.2</td>
</tr>
<tr>
<td>80</td>
<td>-3.1</td>
</tr>
<tr>
<td>75</td>
<td>-6.1</td>
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</table>

Blue Text: Surplus Water for Leaching/Conservation

Red Text: Deficit Water Situation
EFFLUENT & WATER SUPPLY

- Blended With Groundwater
  - Each Acre-Foot Counts As...
    - 0.6 Acre-Feet in Phoenix
    - 0.7 Acre-Feet in Tucson

- 100% Effluent
  - Not Regulated By DWR
  - Local Supply Restrictions?
  - Cost?

- Water Quality
  - Higher Salinity & Sodium
  - Additional Leaching
EFFLUENTS WILL REQUIRE MORE LEACHING

Salts

Leaching Fraction vs. Salinity of Water

- Ryegrass
- Bermudagrass

Varies With Species & Water Quality
## Phoenix Area Turf Water Use Report

**APR, 10 2007**

**Turf: Bermuda**

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>Day Water Use</th>
<th>3 Days Water Use</th>
<th>7 Days Water Use</th>
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<tbody>
<tr>
<td></td>
<td>AC</td>
<td>HO</td>
<td>AC</td>
</tr>
<tr>
<td>Phoenix Greenway</td>
<td>.16</td>
<td>.18</td>
<td>.45</td>
</tr>
<tr>
<td>Phoenix Encanto</td>
<td>.17</td>
<td>.19</td>
<td>.46</td>
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<tr>
<td>Desert Ridge</td>
<td>.17</td>
<td>.19</td>
<td>.47</td>
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<tr>
<td>Mesa</td>
<td>.16</td>
<td>.18</td>
<td>.48</td>
</tr>
<tr>
<td>Buckeye</td>
<td>.15</td>
<td>.17</td>
<td>.46</td>
</tr>
<tr>
<td>Queen Creek</td>
<td>.18</td>
<td>.21</td>
<td>.54</td>
</tr>
<tr>
<td>AREA AVERAGE</td>
<td>.16</td>
<td>.19</td>
<td>.48</td>
</tr>
</tbody>
</table>

**AC:** Acceptable Quality Turf  
**HQ:** High Quality Turf
IRRIGATION SYSTEM PERFORMANCE

Perhaps More Important Than Water Supply!!!

Do We Know Precipitation Rate & Uniformity??

Depth of Water Applied
For Square Spacing of Heads:

\[ PR = \frac{GPM \times 96.3}{D^2} \]

Where: PR is the precipitation rate in inches/hour  
GPM is Discharge of full circle head in gallons per minute.  
D is the spacing distance between adjacent heads in feet.

For Triangular Spacing of Heads:

\[ PR = \frac{GPM \times 96.3}{[D^2 \times 0.866]} \]

Where: PR is the precipitation rate in inches/hour  
GPM is Discharge of full circle head in gallons per minute.  
D is the spacing distance between adjacent heads in feet.
MEASURING PRECIPITATION RATE

Important Aspect of the Irrigation Audit

Catch Can

Catch Cans on Fairway
If you apply 0.30”, some areas will receive more than 0.40” and others less than 0.20”.

IRRIGATION NON-UNIFORMITY

- Brown Spots: No Leaching
- Wet Spots: Runoff Leaching

Amount of Water, In.

0.10 0.20 0.30 0.40 0.50

Area
IRRIGATION NON-UNIFORMITY

If Water is Applied At Rate of ET, You Will Have Areas With Deficit & Excessive Irrigation!!!

No Drainage

No Drainage

Depth of Water Applied
RUN TIME MULTIPLIERS
Run Entire System Extra Time to Wet Dry Areas

Original Application of 0.30”
Run System Extra Time to Eliminate Dry Spots
RUN TIME MULTIPLIERS
Facilitate Leaching But…

- **Playability**
  - Golf Courses & Playing Fields Too Wet

- **System Capacity**
  - Apply 20-40% More Water in Window???

- **Regulatory Limitations**
  - CU = 4.9’ Already
  - Multipliers Require 6-7+ Feet of Water

- **Valve-In-Head Design**
  - Run Individual Heads In Dry Areas
VALVE IN HEAD DESIGN

Run Only These Heads

Run Head In Dry Areas Only!!
RUN TIME MULTIPLIERS
An Obsolete Concept???

To Eliminate Areas Receiving <0.20”…

Running Specific Heads or Pulling Hoses Increases Water Applied By 5%

Running Entire System Increases Water Applied By 43% & Produces Excessive Wetness
PLAYABILITY DICTATES MINIMIZING WET SPOTS!!

Likely Results in Significant Areas of Deficit Irrigation Where Leaching is Insufficient or Non-Existent.
DEFICIT IRRIGATION

Water Applied Insufficient to Meet Evaporative Demand & Drainage Requirements

Mild Deficits: Drainage Slows/ Stops

Larger Deficits: Drainage Stops, Reduced ET/Turf Performance

Salts Accumulate
DEFICIT IRRIGATION REDUCES GROWTH

GROWTH vs. WATER USE
Grasses & Forages

Ratio: Actual to Maximum Yield

Ratio: Actual to Maximum Water Use

Stomata Closed

Stomata Open
A VICIOUS CIRCLE??

- Deficit Irrigation
- Salt & Sodium Accumulation
- Runoff Wet Surface Compaction
- Soil Disperses Poor Infiltration
HOW DO WE EFFECTIVELY LEACH THE ENTIRE TURF AREA?

With Non-Uniformity, Playability & Water Supply Concerns...

- Overseeding
  - Purposely Kept Wet for Germination

- Periods of Excessive Rainfall
  - Especially in Winter
OVERSEED ESTABLISHMENT

We Purposely Over Water To Ensure Dry Spots Will Support Germination

Leaching Required: 2-5”

<table>
<thead>
<tr>
<th>Water TDS ppm</th>
<th>Leaching, % of CU</th>
<th>Leaching, Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bermuda</td>
<td>Ryegrass</td>
</tr>
<tr>
<td>100</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>250</td>
<td>1.1</td>
<td>1.4</td>
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<td>400</td>
<td>1.8</td>
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<tr>
<td>550</td>
<td>2.6</td>
<td>3.2</td>
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<tr>
<td>700</td>
<td>3.3</td>
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<tr>
<td>850</td>
<td>4.1</td>
<td>5.2</td>
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<td>1000</td>
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<td>1600</td>
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<td>1900</td>
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<td>17.4</td>
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<tr>
<td>2500</td>
<td>14.3</td>
<td>18.9</td>
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</tbody>
</table>
WINTER IS BEST TIME TO LEACH

Precipitation Rarely Exceeds ET Over Periods in Excess of a Week

Precipitation ~50% of ET in Winter

ET is Low & Precipitation Higher

Turf Water Use & Precipitation Phoenix

Precipitation: % of ET Phoenix

ET
Precip
WINTER IS THE WORST TIME TO LEACH

Golf: High Demand, High Greens Fees

Rainfall Events Reduce Rounds Played & Courses Won’t Add Additional Water To Leach At This Time of Year
NATURAL LEACHING EVENTS

Monthly Periods When Precipitation Exceeds ETo

Natural Leaching Events
Encanto Park

Note: 6 During The 1990s; Just 2 This Decade
DROUGHT & LEACHING

Chronic Drought Has Reduced Winter Precipitation & Lessened the Number of Natural Leaching Events
SALINITY IS ALREADY A PROBLEM
THE SALINITY TIMEBOMB

Water Restrictions = Lower Quality & Less Water

Salt Accumulation: Increased Salt Load & Less Leaching

Water Quantity

Water Quality

Playability/Deficit Irrigation

Drought
SALINITY MANAGEMENT: LOOKING TO THE FUTURE

- Understand/Monitor Your Water Supply
  - Both Quantity & Quality

- Know & Improve Irrigation System
  - Precipitation Rates & Uniformity

- Know Your Water Use Rates
  - ET & Weather Stations
SALINITY MANAGEMENT: LOOKING TO THE FUTURE

- Maintain Good Surface Soil Structure
  - Chemical & Physical Means

- Leach Your Turf
  - Overseeding & Wet Winter Periods
  - Closing Course 1 Day/Week?

- Improve Turf Salinity Tolerance
THANK YOU

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